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Stock price effects of climate activism: Evidence from the first Global Climate Strike

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ABSTRACT

The first Global Climate Strike on March 15, 2019, represented a historical turning point in climate activism. We investigate the cross-section of stock price reactions to this event for a large sample of European firms. The strike's unanticipated success caused a decrease in the stock prices of carbon-intensive firms. The effect appears to be driven by the increased public attention to climate activism. Furthermore, after the first Global Climate Strike financial analysts downgraded their longer-term earnings forecasts on carbon-intensive firms.

1. Introduction

As extreme weather events become more frequent and severe, the risks of climate change for our societies become dramatically evident. In recent years, the demand for more far-reaching actions at the international level to limit CO2 emissions sparked an unprecedented wave of climate activism by young people. In this paper, we show that this climate activism affects investors' behavior and the market values of firms with high carbon intensity.

We investigate the cross-section of the stock price reactions to the first Global Climate Strike, held on March 15, 2019. Under the slogan "Fridays For Future", this coordinated wave of student climate protests mobilized more than 1.4 million people in over 2000 cities worldwide, receiving massive media coverage.[1] The success of the Global Climate Strike, both in terms of participation and resonance, represented a historical turning point in environmental activism and significantly increased the saliency of climate preferences in the society at large. In addition to its potential relevance for financial markets, the first Global Climate Strike is particularly interesting because it was organized by, and addressed to, young people in the 14–19 age group, who are unlikely to be active participants in the stock markets.[2] Hence, it can be considered quasi-exogenous to investor behavior.

This paper aims at testing whether investors reacted to the first Global Climate Strike by penalizing carbon-intensive firms.

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[1] According to data released on the official website of Fridays for Future: `https://www.fridaysforfuture.org/`.

[2] For details on the demographic characteristics and motivations of strike participants across Europe, see Wahlström et al. (2020).

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Specifically, we investigate the cross-section of cumulative abnormal returns from the day before the Global Climate Strike through three days afterward on a broad sample of European listed companies. We proxy firms' negative environmental externalities by using two different and complementary measures of carbon intensity. First, we consider data on carbon emissions, normalized by value added, from Eurostat available for 64 different industries and 27 countries. Although these data provide information only at the country-industry level, they allow us to analyze the effect of carbon emissions on the cross-section of returns for more than 4000 stocks. Second, we introduce a measure of carbon intensity based on firm-level emission data obtained from Sustainalytics, normalized by market capitalization. This measure is available for around 1800 European firms, which allows us to analyze the relation between stock prices and carbon intensity at a more granular level.

Our results indicate that around the timing of the first Global Climate Strike, firms with higher carbon intensity experienced significantly negative cumulative abnormal returns. For instance, a one-standard-deviation higher carbon intensity at the firm level is associated with 40 basis points lower cumulative abnormal returns, net of the effects of other firm characteristics. These results are robust to using different sets of returns, alternative carbon intensity measures, and also to controlling for environmental, social, and governance (ESG) scores. Our findings suggest that following the event of interest investors penalized firms more exposed to climate change risks.

A relevant question is how a wave of climate protests can stir such effects on financial markets. Thus, we explore the potential channels of our results. We start by focusing on cross-country differences, and we show that carbon-intensive firms located in countries with lower environmental performance experienced a particularly negative stock price reactions. Then, we investigate the role of institutional investors. We find no evidence that our main result is driven by a differential level of institutional ownership before the event. In addition, we study the revisions of analysts' forecast in the month after the first Global Climate Strike. We find that analysts downgraded their expectations on carbon-intensive firms' earnings at the 2021 horizon, but not those at shorter horizons. Finally, we expand the analysis to a longer time frame through June 30, 2019, which allows us to study the role of media and public attention to climate activism. We provide this analysis using Google search volume and firm news. We find that negative abnormal returns are associated to firms with high carbon intensity and higher daily attention to climate activism, especially when those firms are under intense public scrutiny.

Overall, these findings suggest that the climate strike contributed to renew investors' attention to already-existing corporate risks concerning climate change. The market takes into account firms' environmental performance anticipating a possible reduction in future cash flows, tightening of environmental regulation or increasing public attention. Indeed, in the near future, carbon-intensive firms will face several challenges, which may include lower operating performance, higher financing costs, and significant mitigation and adaptation risks.

Our study contributes to the literature on the relation between asset prices and firms' environmental performance. In theoretical settings, for example, Pastor et al. (2020) and Pedersen et al. (2020) include environmental preferences. In particular, Pastor et al. (2020) show that brown assets underperform in reaction to unexpected positive shifts in environmental preferences, even if, in equilibrium, they should overperform the market. Similarly, Fama and French (2007) and Zerbib (2020) show that investors' taste for green assets can affect asset prices. Indeed, extensive evidence show that the behavior of a fraction of investors is motivated also by non-pecuniary motives, sometimes even irrespectivelly of risk and return considerations (see, e.g., Hartzmark and Sussman, 2019, and Barber et al., 2021). A vast body of empirical literature provides mixed results on the relation between stock returns and firms' environmental performance (see, e.g., Derwall et al., 2005, and Alessi et al., 2021, among others). Indeed, the potential drivers explaining these findings are challenging to identify. Bolton and Kacperczyk (2020a, 2020b) and Hsu et al. (2020) provide evidence that high carbon emissions are generally associated with higher realized returns, presumably due to environmental policy uncertainty and unrealized regulation risks. Ilhan et al. (2021) and Ramelli et al. (2021) use the 2016 U.S. election as an empirical setting to identify the pricing-in of regulatory risks associated with higher carbon intensity in the option and stock markets, respectively. A growing number of institutional investors also integrate sustainability considerations – particularly with respect to climate change – in their investment decisions (e.g., Dyck et al., 2019, and Krueger et al., 2020).[3] Choi et al. (2020) find that stocks of carbon-intensive firms underperform following abnormally warm weather, while Engle et al. (2020) and Huynh and Xia (2020) study the effect of climate-related news. Our paper contributes to this literature by documenting how climate activism influences the market's pricing of corporate climate externalities.

In addition, our paper is also related to the broader literature relating firm environmental performance to capital structure and financing costs. Several studies indicate that firms with good environmental performance, or better environmental risk management practices, enjoy a lower cost of equity (see, e.g., Sharfman and Fernando, 2008, Ghoul et al., 2011, and Cheng et al., 2014). On the debt market, environmental responsible firms enjoy lower yield spreads on corporate bonds, particularly where regulatory risks are higher (Seltzer et al., 2021). Moreover, Baker et al. (2018) and Fatica et al. (2021) find that green bonds are issued at a premium compared to ordinary bonds. Also Deng et al. (2020) find a premium for green bonds, mainly when the underlined projects are entirely green or went through independent parties' external review.[4] In Tang and Zhang (2020) green bond issuance announcements are followed by a

[3] According to Global Sustainable Investment Alliance (2019), as of 2018, the assets managed according to socially responsible criteria accounted for around 30 trillion USD globally. According to the NGO Global Sustainable Investment Alliance (2019), as of the same year, around 1000 institutions with combined assets of around 8 trillion USD committed to divest from fossil fuels.

[4] Yet, results differ with respect to the market considered and the period. For instance, Karpf and Mandel (2018), find a positive premium focusing on municipal bonds on the secondary market. Fatica et al. (2021) do not find a yield difference for green bond issued by financial institutions, and Zerbib (2019) find a small negative premium considering green bonds issued between 2013 and 2017.

positive stock price reaction. In addition, Kleimeier and Viehs (2018) document that corporate loan spreads are positively related to borrowers' carbon emissions. Delis et al. (2019) find that after the Paris Climate Agreement, banks started charging higher loan rates to firms with higher fossil fuel reserves. Nguyen and Phan (2020) report a decrease in financial leverage by carbon-intensive companies following more stringent carbon regulation. Our results indicate that the intensification of climate activism in society may contribute to increase the financing costs of carbon-intensive firms.

The paper proceeds as follows. Section 2 introduces our main empirical strategy and hypothesis. Section 3 describes the data. Section 4 presents the main results. Section 5 discusses the potential determinants of the main findings. Section 6 extends the analysis to a longer time frame and considers the role of media and public attention to climate activism. Finally, Section 7 concludes.

2. Empirical strategy

We assume that the excess return $R_{i,\,t}$ of company $i = 1, \ldots, n$, at date $t = 1, 2, \ldots T$ satisfies the following linear factor model:

$$R_{i,t} = a_i + b_i' f_t + \varepsilon_{i,t}, \tag{1}$$

where a_i is the constant coefficient, f_t is a vector of K observable factors, b_i is the vector containing the corresponding k factor loadings and $\varepsilon_{i,\,t}$ is the error term. To study the stock-price reactions to the first Global Climate Strike, we compute abnormal return $AR_{i,\,t}$ as:

$$AR_{i,t} = R_{i,t} - \left(\widehat{a}_i + \widehat{b}_i' f_t \right), \tag{2}$$

where $\widehat{a}_i$ and $\widehat{b}_i$ are estimated from OLS regression on Eq. (1) using daily stock excess returns data from January 2, 2018 through December 31, 2018. Defining abnormal returns by adjusting for the Jensen's alpha, allows us to focus directly on the effect of the event under study, net of the systematic under- or out-performance of specific stocks.

Our baseline model is the CAPM (Sharpe, 1964), i.e., the market model with $K = 1$ and the observable factor $f_t = r_{m,\,t}$, where $r_{m,\,t}$ is the excess return on the value-weighted market portfolio over the risk free rate. Indeed, the advantages from employing multifactor models for event studies are limited (see, e.g., Campbell et al., 1997). However, in Section 4.1, for comparison reasons, we collect results for the four-factor model (hereafter, labeled as 4F) proposed in Carhart (1997), with $f_t = (r_{m,\,t}, r_{smb,\,t}, r_{hml,\,t}, r_{mom,\,t})'$, where $r_{smb,\,t}$ and $r_{hml,\,t}$ are the returns on zero-investment factor-mimicking portfolios for size and book-to-market, respectively, and $r_{mom,\,t}$ is the momentum factor, i.e., the equal-weight average of the returns for the winner portfolios minus the average of the returns for the loser portfolios (Fama and French, 1993).

For our empirical purposes, the choice of the event window is of particular importance. On the one hand, we need to balance the necessity to keep the event window as short as possible to limit the concerns on potential confounding events; on the other hand, we need an event window allowing enough time for markets to realize the success of the first Global Climate Strike, and integrate into prices information outside the traditional realm of finance. To define the most appropriate event window, Fig. 1 shows the daily global Search Value Index (SVI) from Google Trends for Greta Thunberg, the initiator and inspiring leader of the "Fridays For Future" movement. Fig. 1 provides valuable information for our empirical strategy. The attention to the climate activist spikes around March 14, 2019, and remains at relative high levels up to March 20, 2019. First, this surge in attention suggests that, although the date and goals of the first Global Climate Strike were known in advance, its success in terms of participation and ex-post public attention was largely unanticipated, hence supporting the relevance of the event under study.[5] Second, Fig. 1 indicates that an appropriate event window for our analysis is from the day before the Global Climate Strike (March 14, 2019) up to three trading days after the strike (March 20, 2019), i.e., the days of relative high public attention to Greta Thunberg.[6]

Thus, we compute the cumulative abnormal returns, $CAR_i(t_1, t_2)$, over a 5-day window ranging from 1 day before through 3 days after the event ($[-1, +3]$) by compounding individual stocks' daily returns between March 14 and March 20, 2019.

To investigate how carbon intensity affects abnormal returns around the event window of interest, we study the following cross-sectional specification:

$$CAR_i(t_1, t_2) = \alpha + \beta CI_i + X_i' \gamma + e_i, \tag{3}$$

where CI_i is the carbon intensity measure, and X_i is a vector of accounting variables (e.g., market capitalization, leverage, profitability, and book-to-market).[7]

[5] Factiva Dow Jones indicates that the number of press articles mentioning Greta Thunberg appeared on European newspapers passed from being 1488 and 2590 in January and February 2019, respectively, to 8378 in March 2019.

[6] A concern in event study applications is the role of potential confounding effects (McWilliams and Siegel, 1997). We conducted a research on Factiva to ensure that no other significant market-wide events related to climate change or carbon pricing occurred during the selected event window. Over the same period, we also do not observe any significant increase in the spot or future prices of emission allowance units under the European Union Emission Trading System (EU ETS), which would have negatively affected more carbon-intensive firms.

[7] For easier notation, the measure of carbon intensity CI_i is defined for each company i. However, in Section 3.2, we also introduce carbon intensity measures defined at the country-industry level. In that case, the specification in Eq. (3) becomes $CAR_i(t_1, t_2) = \alpha + \beta CI_{c,\,j} + X_i' \gamma + e_i$, where $CI_{c,\,j}$ is the carbon intensity measure of country c and industry j in which company i belongs.

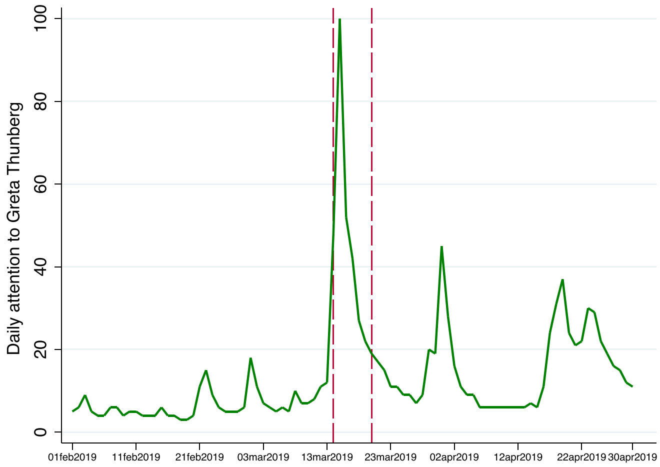

Fig. 1. Google search index on Greta Thunberg.
This figure shows the daily global Google Trends Search Value Index (SVI) for the topic "Greta Thunberg" from February 1, 2019, through April 30, 2019 (including non-trading days). The index varies from 0 to 100 and represents search interest relative to the highest point on the chart. The two vertical dashed lines indicate our chosen estimation windows of 5 trading days, ranging from Thursday, March 14, through Wednesday, March 20, 2019.

Our hypothesis is that the relationship between firm's carbon intensity and stock price reaction to climate activism is negative. In other words, we expect firms with higher carbon intensity to underperform in reaction to the first Global Climate Strike. The null hypothesis is that this event did not have any influence on the behavior of (marginal) investors with respect to firms' carbon emissions.

3. Data and summary statistics

In this section, we introduce the data involved in our analysis. First, we provide information on stock returns. Then, we present carbon intensity measures, and we describe accounting variables used in the application. Finally, we comment the descriptive statistics of the final datasets.

3.1. Stock returns

We obtain daily stock prices from January 2, 2018 through June 30, 2019 for all listed firms head-quartered in Europe (EU 28, Switzerland and Norway) from Compustat Security Daily. To compute stock returns, we follow the procedure used in Chaieb et al. (2021). We keep only common shares (tpci = "0") listed on major stock exchanges.[8] In cases of dual listings, we keep only the firm's security with the highest market capitalization, remaining with approximately 5800 securities traded as of March 14, 2019. We convert all prices in USD using the appropriate daily currency conversion rates provided by Compustat Global. We also adjust prices for dividends through the daily multiplication factor and the price adjustment factors.

We obtain data on European market, size, value, and momentum factors, in addition to the risk-free asset, from Kenneth French's website. The risk-free rate is the U.S. one month T-bill rate.[9] For each stock i, we estimate the vector of factor loadings b_i in Eq. (1), using daily stock excess returns from January 2, 2018 through December 31, 2018 (the estimation period). Then, we compute abnormal returns, $AR_{i,t}$, for the period from January 1, 2019 through June 30, 2019, as defined in Eq. (2). To ensure that the estimates are not affected by numerical instability, we compute abnormal returns only for stocks with at least 127 daily observations available during the estimation period.

3.2. Carbon intensity measures

We consider two measures of carbon intensity, one at the country-industry level and the other at the firm level. These two measures offer complementary advantages. The first one allows us to conduct cross-sectional analyses on a larger sample, while the second one is suited to exploit the within-industry variation in climate performance.

At the country-industry level, data on carbon intensity are retrieved from Eurostat Air emissions accounts (AEA).[10] AEA are

[8] Major stock exchanges are defined as the exchange with the highest number of equities per country, except for France (Paris and NYSE Euronext), Germany (Deutsche Boerse and Xetra), and Switzerland (Zurich and Swiss Exchange) where two exchanges are selected.
[9] Consistent with the European market factor, which is defined with respect to the T-bill rate, we proxy the risk-free rate with the 30-day T-bill beginning-of-month yield.
[10] They are part of the European environmental economic accounts (Regulation (EU) No 691/2011).

compiled at national level but follow the accounting structures and principles of the System of Environmental-Economic Accounting, producing internationally comparable and coherent statistics on the environment and its relationship with the economy. Greenhouse gases (GHG) include CO2 plus other air pollutants expressed in CO2 equivalents. Data are published at annual frequency, broken down by country and economic activity. The industry classification of economic activities is based on NACE Rev. 2 with details for 64 emitting industries.[11] Based on Eurostat data, we define the variable *Carbon intensity (country-industry)*, computed as the ratio between total GHG and the value added.[12] As alternative measure, we also consider the carbon intensity from Eurostat defined as the ratio between GHG and value of output. We use the data from the last available Eurostat release before the first Global Climate Strike, which refers to the year 2017.

The second carbon intensity measure involved in our analysis is derived by firm level carbon data provided by Sustainalytics. We define the variable *Carbon intensity (firm)* as a firm's total Scope 1 and Scope 2 CO2 emission equivalents in 2018, divided by its market capitalization as of the day before the first Global Climate Strike.[13] Using the market value of equity to normalize GHG emissions emphasizes the amount of a firm's negative environmental externalities relative to its current overall value for shareholders (see, e.g., Hoffmann and Busch, 2008, and Ilhan et al., 2021). However, in Section 4.1, we show that our results hold also when using alternative definitions of carbon intensity, computed using the book value of equity, total assets, or revenues at the denominator.

3.3. Accounting data

We retrieve information on basic firm characteristics from Compustat Global, i.e., market value of equity, market leverage, profitability, and book-to-market. Accounting data refers to fiscal year 2018, except for an approximately 10% of firms for which we use 2017 data as their fiscal year 2018 ended after March 15, 2019. We convert all accounting data in USD using the Compustat currency conversion tables and 12-month average exchange rates.

Market capitalization is computed as the share price as of March 13, 2019, times the number of shares outstanding on the same day. Market leverage is defined as the ratio between equity and total assets. Profitability corresponds to the return on assets (ROA). Finally, the book-to-market is the book value divided by the market value of equity.

3.4. Summary statistics

We merge CAPM-adjusted cumulative abnormal returns from Eq. (3), and firm accounting information from Compustat, with the carbon intensity at the country-industry level from Eurostat. We end up with a sample of 4244 stocks. Then, in a similar way, we built a subsample merging the emissions data at the firm level downloaded from Sustainalitycs. The corresponding sample includes 1859 firms. Table A1 in the Appendix provides the distribution of firms by country of headquarters for the two samples. Distributions look similar, in particular, about half of the firms are domiciled in the United Kingdom, France and Germany. More information on carbon intensity at the firm level, than at the country-industry level, is available for Sweden and Switzerland.

Table 1 Panels A and B report descriptive statistics on the carbon intensity, financial and accounting data involved in the samples based on data from Eurostat and Sustainalitycs, respectively. The distributions of carbon intensity measures are similar. The average carbon intensity is around 0.3, and the standard deviation is approximately 0.9. The distributions of carbon intensity are highly skewed with a low number of observations having high values. Importantly, the carbon intensity measure at the firm level has some variability also within industries, for example the standard deviation is higher than 1 for the stocks in the utilities and materials GICS sectors. Focusing on the financial information, we observe a large standard deviation for both the cumulative raw returns and the cumulative returns estimated from the CAPM-adjusted. However, the average abnormal return is approximately zero as the systematic risk is captured by the market factor. Finally, the distributions of accounting variables in Table 1 have similar characteristics in the two samples.

Fig. 2 shows the average 5-days cumulative CAPM-adjusted abnormal returns by GICS sector of the Eurostat sample.[14] Within the event window, firms in the energy and material sectors, characterized by higher carbon intensity levels, appear to have underperformed the market. On the contrary, the low-carbon intensity sectors, i.e., telecommunication services and financials, show a positive abnormal stock returns.[15]

[11] Since 1970 NACE, derived from the French Nomenclature statistique des Activités économiques dans la Communauté Européenne, is the official industry classification used in the European Union. NACE Rev. 2 is a revised classification adopted at the end of 2006. The 64 industries are the most granular level to which the GHG data are available. Alternative datasets provide information at the country level, without a breakdown at industry level (e.g., Germanwatch, Worldbank).

[12] The *Carbon intensity (country-industry)* is expressed in kilotons of CO2 emissions equivalent per millions of USD.

[13] According to the GHG Protocol, there are three types of emission categories, Scope 1, 2 and 3. Scope 1 refers to all direct emissions from the activities of a company. Scope 2 considers indirect emissions created during the production flow. Scope 3 includes emissions that are a consequence of the operations of a company, but are not under its direct control. Scope 1 and 2 should always be reported by firms in the carbon footprint. Scope 3 is an optional reporting category.

[14] We consider the GICS industry classification mostly because of its popularity in the finance industry. In addition, the GICS classification is known to explaining stock return comovements relatively well (e.g., Bhojraj et al., 2003).

[15] Note that the sector "Telecommunication services" includes 77% of firms in "Media and Entertainment" subsector, and 23% of firms in "Telecommunication Services". Furthermore, we get a similar picture by using data on *Carbon intensity (firm)* from Sustainalytics.

Table 1
Summary statistics. The table presents descriptive statistics of the main variables. Panels A and B report statistics for the samples obtained by merging financial and accounting data with carbon intensity data. Carbon intensity variables at the country-industry and firm levels are downloaded from Eurostat and Sustainalytics, respectively. *Carbon intensity (country-industry)* is the ratio between GHG emissions in kt of CO2 equivalents (ktCO2eq) and the industry's value added. *Carbon intensity (firm)* is computed as the total 2018 Scope 1 and 2 GHG emissions in kt of CO2 equivalents (ktCO2eq) divided by market value of equity in million USD. Cumulative raw returns are computed from March 14 through March 20, 2019. CAR indicates cumulative abnormal returns. CAPM-adjusted abnormal returns, from March 14 through March 20, 2019, are computed as defined in Eq. (2) where f_t is the excess return on the value-weighted European market portfolio. The 4F-adjusted abnormal returns are computed as defined in Eq. (2) with $f_t = (r_{m,\ t}, r_{smb,\ t}, r_{hml,\ t}, r_{mom,\ t})'$, where $r_{smb,\ t}$ and $r_{hml,\ t}$ are the returns on zero-investment factor-mimicking portfolios for size and book-to-market, respectively, and $r_{mom,\ t}$ is the momentum factor, i.e., the equal-weight average of the returns for the winner portfolios minus the average of the returns for the loser portfolios (see Carhart, 1997). $\widehat{b}_m$ is the factor exposures on daily market excess return from January 2, 2018 through December 31, 2018. Accounting variables (in USD) refer to 2018 and are computed as follows: *Log market cap* is the logarithm of firms' market capitalization as of March 13, 2019; *Leverage* is defined as equity over total assets; *Profitability* corresponds to the return on assets (ROA); *Book-to-market* is the book value of equity divided by market valuation. Carbon intensity measures and accounting variables are winsorized at 1–99 percentiles.

	N	Mean	sd	p5	p25	p50	p75	p95
	Panel A: Eurostat sample							
Carbon intensity (country-industry)	4244	0.317	0.896	0.001	0.008	0.029	0.090	2.130
5-day cumulative raw return	4244	1.171	6.967	−7.388	−1.022	0.798	3.146	9.782
5-day CAPM-adjusted CAR	4244	0.030	6.998	−8.366	−2.298	−0.208	1.952	8.675
5-day 4F-adjusted CAR	4244	0.245	7.014	−8.098	−2.082	−0.042	2.134	8.876
$\widehat{b}_m$	4244	0.815	0.445	0.171	0.505	0.776	1.086	1.612
Log market cap	4244	18.999	2.469	15.169	17.206	18.906	20.713	23.170
Leverage	4244	0.222	0.203	0.000	0.051	0.184	0.333	0.593
Profitability	4244	−3.789	24.785	−49.431	−2.576	2.441	6.057	14.711
Book-to-market	4244	0.892	1.286	0.051	0.307	0.636	1.125	2.653
	Panel B: Sustainalytics sample							
Carbon intensity (firm)	1859	0.301	0.936	0.001	0.005	0.021	0.115	1.690
5-day cumulative raw return	1859	1.703	4.714	−4.857	−0.167	1.535	3.615	7.960
5-day CAPM-adjusted CAR	1859	0.089	4.710	−6.211	−1.806	−0.054	1.968	6.106
5-day 4F-adjusted CAR	1859	0.269	4.715	−5.987	−1.607	0.105	2.089	6.457
$\widehat{b}_m$	1859	1.007	0.385	0.435	0.741	0.984	1.240	1.693
Log market cap	1859	20.994	1.865	17.742	19.888	20.961	22.204	24.079
Leverage	1859	0.232	0.177	0.000	0.089	0.215	0.345	0.543
Profitability	1859	2.789	13.813	−13.170	0.993	3.737	7.398	16.737
Book-to-market	1859	0.752	0.895	0.087	0.292	0.572	0.931	1.953

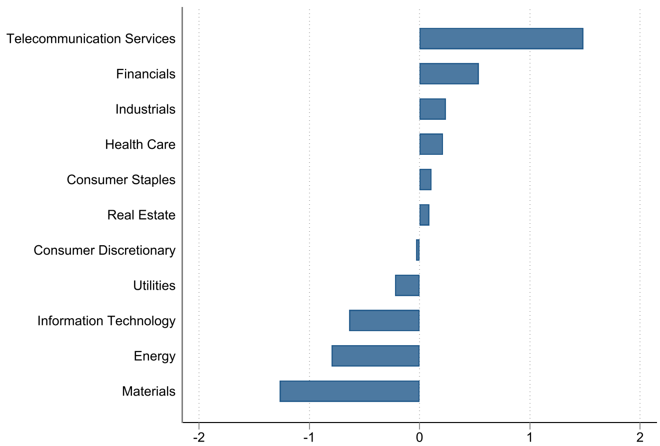

Fig. 2. Average cumulative return by sector.
The figure shows the average 5-day CAPM-adjusted cumulative abnormal returns by 11 GICS sectors for 4244 firms for the Eurostat sample including data on *Carbon intensity (country-industry)*.

4. Main results

In this section, we investigate the cross-sectional relationship between the stock price performance around the climate strike and firms' carbon intensity. The analysis is based on Eq. (3) where the adjusted cumulative abnormal returns $CAR_i(t_1, t_2)$ are computed for the CAPM over the 5-day window, as defined in Section 2, and the measure of carbon intensity is defined at the country-industry or firm levels.

Specifications 1 and 2 in Table 2 report results for the carbon intensity defined at the country-industry level. In specification 1, without any controls, the coefficient on carbon intensity is negative and highly statistically significant. Including firm controls in specification 2, the coefficient of interest remains negative and statistically significant. A one-standard-deviation increase in *Carbon intensity (country-industry)* is associated with 19 basis points reduction in the 5-day cumulative abnormal returns. The result is consistent with previous works documenting that differences across industries play an important role in driving the effect of carbon emissions on investor behavior and stock returns (Bolton and Kacperczyk, 2020a, and Ilhan et al., 2021). None of the coefficients on firm control variables is statistically significantly different from zero. This result is not surprising because the firm control variables are well captured through the systematic risk components of Eq. (1).

Specifications 3 and 4 in Table 2 provide results using the measure of carbon intensity at the firm level, and show a negative and highly statistically significant effect of *Carbon intensity (firm)* on the 5-day cumulative abnormal returns. Considering the estimates in specification 4, controlling for sector and country fixed effects, a one-standard-deviation increase in *Carbon intensity (firm)* is associated with a decrease in cumulative returns equal to 42 basis points.[16]

Overall, the results indicate that the first Global Climate Strike had a negative effect on the stock prices of high carbon-intensive firms. To illustrate this finding, Fig. 3 shows the evolution of $\widehat{\beta}$, i.e., the estimated coefficients of *Carbon intensity (country-industry)* (solid line) and *Carbon intensity (firm)* (dashed line) looking at returns from two weeks before the first Global Climate Strike (March 1, 2019) through two weeks after it (March 27, 2019). Specifically, the coefficients are obtained by regressing the CAPM-adjusted cumulative abnormal returns from March 1, 2019, up to each day.[17] We observe a negative trend starting on the Monday before the Global Climate Strike – attributable to a natural anticipation of the event. This indicates that results in Table 2 provide a lower bound of the market effects of the first Global Climate Strike. The stock-price penalty on carbon intensity downturns on the exact day of the climate strike. Moreover, it remains negative and statistically significant even after 10 days, without any apparent short-run reversal.[18]

Overall, the results presented in this section indicate that the success of the first Global Climate Strike negatively impacted the market valuation of carbon-intensive firms.

4.1. Robustness checks

In this section, we provide several robustness checks to ensure the reliability of the findings described in the previous section. Specifically, we focus on three dimensions: i) the definition of returns used as dependent variable, ii) the definition of carbon intensity measure, and iii) controlling for ESG scores.[19]

In Table A3, we estimate Eq. (3) by using 5-day cumulative raw returns and 4F-adjusted cumulative abnormal returns as dependent variables. All previous results are confirmed, both when considering carbon intensity at the country-industry level, in specifications 1 and 2, and at the firm level, in specifications 3 and 4. This is not surprising, as in the estimation procedure we control for firm characteristics that are highly correlated to factor loadings (in particular, size and book-to-market). In Table A4, we use alternative definitions for the carbon intensity measures (as done, for instance, also in Cheema-Fox et al., 2019, and Hsu et al., 2020). At the country-industry level, we consider the ratio of GHG emissions over the output value. At the firm level, we compute alternative carbon intensity measures by normalizing Scope 1 and Scope 2 emissions by the firm's book value of equity, total assets, or revenues. The stock-price effects associated with these alternative measures of carbon intensity are in line with the ones shown in Table 2.

Finally, in Table A5, the analysis accounts for firms' ESG scores, non-financial ratings providing a quantitative assessments of a firm's ESG policies and commonly used in finance research (e.g., Ferrell et al., 2016, Liang and Renneboog, 2017, and Lins et al., 2017).[20] We retrieve ESG scores from Refinitiv/Asset4. The scores, ranged from 0 to 100, are computed starting from a subset of 186

[16] The magnitude of the identified effect is comparable with the results of other recent empirical analysis on the stock-price effect of carbon intensity. Ramelli et al. (2021) find that Trump's election caused an out-performance of one-standard-deviation higher carbon intensity equal to approximately 71 basis points over a 5-day window. In a panel setting on U.S. firms, Bolton and Kacperczyk (2020a) show that over the 2005–2017 period, a one-standard-deviation increase in the level of scope 1 emissions is associated with 15-basis-point higher monthly returns as a remuneration for higher carbon risks. Choi et al. (2020) find that a one-standard-deviation increase in abnormal temperature is associated with a 16-basis-points reduction in the monthly return of a long-short equal-weighted emission-minus-clean portfolio.

[17] The loadings β are estimated from specifications 2 and 4 in Table 2, for the samples including carbon intensity at the country-industry level and firm level, respectively.

[18] The estimated coefficients are negative and statistically significant at 5% (10%) level starting from March 13 (March 17) for the carbon intensity at the country-industry (firm) level.

[19] We also performed other robustness tests, obtaining similar results, excluding from the sample financial firms (GICS code equal to 40) and controlling for a more granular sector classification based on GICS industry groups. We also ensured that the coefficient on *Carbon intensity (country-industry)* remains statistically significant when clustering standard errors at the country-industry level. The estimates on both *Carbon intensity (country-industry)* and *Carbon intensity (firm)* remain highly statistically significant even when accounting for the potential cross-sectional correlation of standard errors along the "time" dimension, following the approach in Cohn et al. (2016) and considering the empirical distribution of the coefficients over a non-event period from January 2, 2019 through February 28, 2019.

[20] ESG ratings are computed by different research providers on the basis of companies' public-available information, questionnaires to firms, and other sources (e.g., media, NGOs). Recently contributions have suggested that ESG ratings from different providers do not have a very strong correlation because of, for instance, differences in the assessment of various ESG components and in the methodology to aggregate them (Chatterji et al., 2016; Berg et al., 2020, and Gibson et al., 2020).

Table 2
Main results: Stock price reactions to the first Global Climate Strike. The table reports estimation results of Eq. (3) of 5-day CAPM-adjusted cumulative abnormal returns on carbon intensity measures at the country-industry level (columns 1 and 2), and firm level (columns 3 and 4). Specifications 2–4 control for firm characteristics. Specification 4 includes sector and country fixed effects. *t*-statistics based on robust standard errors are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	5-day CAPM-adjusted CAR			
Carbon intensity (country-industry)	−0.202**	−0.208**		
	(−2.549)	(−2.528)		
Carbon intensity (firm)			−0.423***	−0.452***
			(−2.950)	(−2.780)
Log market cap		0.049	−0.050	−0.023
		(0.890)	(−0.726)	(−0.289)
Leverage		0.189	1.101	1.014
		(0.285)	(1.542)	(1.213)
Profitability		−0.009	0.005	0.005
		(−1.003)	(0.500)	(0.458)
Book-to-market		0.029	0.405	0.416
		(0.224)	(1.162)	(1.099)
Constant	0.116	−0.939	0.693	1.172
	(1.069)	(−0.806)	(0.474)	(0.648)
Observations	4802	4244	1859	1859
R-squared	0.001	0.002	0.012	0.039
Sector FE	No	No	No	Yes
Country FE	No	No	No	Yes

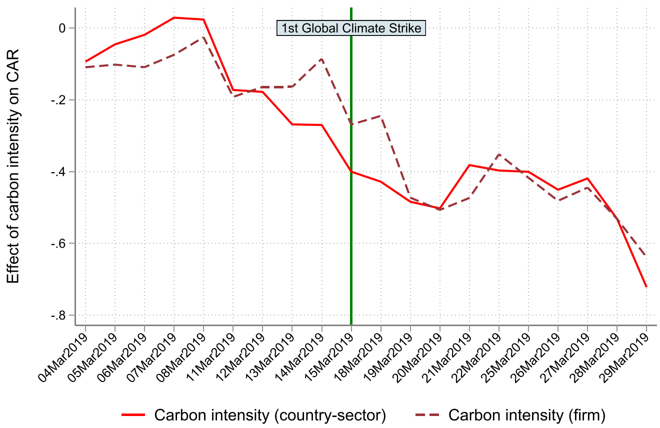

Fig. 3. Global Climate Strike and stock-market carbon price.
The figure shows the evolution of the estimated coefficient β in Eq. (3), by regressing CAPM-adjusted cumulative abnormal returns from 10 days before through 10 days after the Global Climate Strike on the carbon intensity measure defined at the country-industry level (solid line), and at the firm level (dashed line). The cumulative returns are computed starting on March 1, 2019 (day −10).

metrics in 10 different categories, which are grouped into three pillar scores – environment, social, and governance.[21] Our main result, i.e., the importance of carbon intensity in explaining the stock price performance around the first Global Climate Strike, holds after controlling for the environmental score (specifications 1 and 2), the governance score (specifications 3 and 4), or the overall ESG score (specifications 5 and 6).

5. Potential channels

In this section, we study the potential channels behind the loss in value for high carbon-intensive firms around the occurrence of the first Global Climate Strike. We start this investigation by uncovering cross-country differences in environmental aspects that characterize our sample. Then, we study the role of institutional investors and the revisions of analysts' earnings forecasts following the

[21] The environmental pillar score is determined based on three categories: resource use, emissions, and innovation. The social pillar score is based on the workplace, human rights, community, and product responsibility category scores. The governance pillar scores is based on the management, shareholders, and corporate social responsibility strategy categories.

event of interest.

5.1. Cross-country heterogeneity

Given that our sample includes firms located in Europe, we can explore the cross-country dimension of our main result. Previous literature recognizes climate policy and environmental regulation as major drivers of the price of carbon intensity on firm value (e.g., Bolton and Kacperczyk, 2020b, Hsu et al., 2020, and Ramelli et al., 2021).

In this section, we consider the Environmental Performance Index (EPI), a composite indicator that measures how close countries are to established environmental policy targets, and the Notre-Dame Global Adaptation Index (ND-GAIN), a measure of a country ability to face climate change.[22] These indicators approximating the sustainability performance of a country allow us to split the sample between firms domiciled in countries with high scores (i.e., Austria, Denmark, Finland, France, Germany, Great Britain, Luxembourg, Norway, and Switzerland are in the top quartile), and firms head-quartered elsewhere.

Table 3 reports the results of our main regressions by splitting the sample in firms located in countries with low (specifications 1 and 3) and high levels of environmental indexes (specifications 2 and 4). Both at the country-industry and firm levels, the market penalization for carbon-intensive firms appears statistically significant only for the sub-sample of firms located in countries with low level of environmental indexes.[23] The documented cross-country heterogeneity highlights that markets' reactions to an intensification in climate activism are likely to differ not only on a firm's environmental profile, but also on the environmental aspects related to the specific country of a firm.

5.2. The role of institutional investors

Recent studies show the importance of climate risks and environmental considerations for institutional investors (Dyck et al., 2019, Brandon et al., 2020, and Krueger et al., 2020). In this section, we investigate whether our main result is driven by institutional ownership. We obtain firm's ownership data from Bureau van Dijk's (BvD) Orbis database (see, e.g., Aminadav and Papaioannou, 2020 for a recent study on corporate control around the world based on Orbis), which provides detailed ownership data including the percentage of direct shares and the type of shareholders. We use this information to construct the variable *IO* defined as the fraction of total shares hold by institutional investors in each firm as of the end of 2018. Following Ferreira and Matos (2008), we define institutional investors as insurance company, hedge fund, mutual, and pension fund, nominee, trust and trustee. In Table 4, we add to our empirical specification the variable *IO*, and the interaction term with carbon intensity to test whether the negative relationship between carbon intensity and the adjusted cumulative abnormal returns differs across firms with different levels of institutional ownership before the event.

In all specifications the coefficient on *IO* is not statistically significant. Also, the interaction term between *IO* and carbon intensity, both for the measure at the country-industry (specifications 1–2) and the firm (specifications 3–4) levels, is not statistically significant. While data limitation does not allow us to derive conclusive evidence on trading behavior and changes in ownership around the event, we can assert that the reduction in value of stock prices of firms operating in carbon-intensive activities did not have a differential effect based on the overall level of institutional ownership.[24]

5.3. Revisions of analysts' earnings forecasts

Analysts are very influential agents in financial markets. Studying their earnings forecasts can provide valuable information about changes in market's expectations on the future prospects of individual firms, and can help researchers better understanding drivers of price changes (see, e.g., Brown and Rozeff, 1978, and Fried and Givoly, 1982). In this section, we test whether in the weeks following the first Global Climate Strike financial analysts revised downward their expectations on the future operating performance of high carbon intensive firms.

We retrieve data on annual earnings forecasts from the IBES (I/B/E/S) Summary History international dataset, which provides monthly summary statistics of analysts' forecasts on individual firms as of the day before the third Friday of each month. This time frame aligns well with our empirical setting, as it provides a snapshot of analysts' earnings expectations as of March 14, 2019, the day before the first Global Climate Strike. Thus, we study how these expectations changed in the course of the following month through April 18, 2019.

We focus on analysts' expectations on annual earnings per share (EPS): (i) EPS-2019, accounting year ending between April 30, 2019, and December 31, 2019; (ii) EPS-2020, accounting year ending between January 1 and December 31, 2020; (iii) EPS-2021, accounting year ending between January 1 and December 31, 2021. We use the consensus (i.e., median) forecast as proxy for

[22] The EPI is constructed from 32 sustainability indicators across 11 issue categories covering several aspects of a country environmental performance. The ND-GAIN is based on 45 indicators measuring the vulnerability of a country to be impacted by future changing climate conditions and the readiness to make effective use of investments for adaptation actions thanks to its business environment.

[23] The coefficients on carbon intensity in specifications 3 and 4 are statistically different from each others at 10% level.

[24] Ideally, we would like to investigate the changes in ownership by different group of investors after the first Global Climate Strike. However, differently from other datasets that provide quarterly information, such as Thomson-Reuters Mutual Fund Holdings database, the ownership module of Orbis is less precise in the time series dimension.

Table 3
Countries' Environmental Performance. The table reports estimation results of Eq. (3) of 5-day CAPM-adjusted cumulative abnormal returns on carbon intensity measures. Specifications 1 and 3 (2 and 4) refer to countries with low (high) environmental performance. Countries with high levels of environmental performance are either in top quartile of EPI (an indicator of environmental sustainability) or ND-GAIN (a measure of ability to face the potential adverse effects of climate change). All specifications includes firm characteristics and country fixed effects. Specifications 3 and 4 include also sector fixed effects. *t*-statistics based on robust standard errors are shown in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	5-day CAPM-adjusted CAR			
	Low	High	Low	High
Carbon intensity (country-industry)	−0.274**	−0.163		
	(−2.464)	(−1.171)		
Carbon intensity (firm)			−0.744***	−0.193
			(−2.757)	(−1.134)
Observations	1723	2531	722	1137
R-squared	0.018	0.007	0.067	0.024
Firm controls	Yes	Yes	Yes	Yes
Sector FE	No	No	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

Table 4
Institutional ownership. The table reports estimation results of Eq. (3) of 5-day CAPM-adjusted cumulative abnormal returns on carbon intensity measures at the country-industry level (columns 1 and 2), and firm level (columns 3 and 4). Institutional ownership (*IO*) is defined as total institutional ownership in percentage. Specifications 2–4 control for firm characteristics. Specification 4 includes sector and country fixed effects. *t*-statistics based on robust standard errors are shown in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	5-day CAPM-adjusted CAR			
Carbon intensity (country-industry)	−0.189**	−0.192**		
	(−2.123)	(−2.166)		
Carbon intensity (firm)			−0.440***	−0.496***
			(−2.791)	(−2.753)
IO	0.002	0.005	0.011	0.013
	(0.236)	(0.668)	(1.328)	(1.491)
Carbon intensity (country-industry)*IO	−0.006	−0.007		
	(−0.818)	(−0.942)		
Carbon intensity (firm)*IO			0.002	0.004
			(0.631)	(1.202)
Observations	4491	4101	1718	1718
R-squared	0.001	0.002	0.015	0.044
Firm controls	No	Yes	Yes	Yes
Sector FE	No	No	No	Yes
Country FE	No	No	No	Yes

analysts' beliefs. Specifically, for each horizon h (2019, 2020, 2021) and firm i, we compute the revision in percentage change in the median earnings forecast between March 14 and April 18, 2019, i.e., $\Delta EPS_{i,h} = \frac{\mathbb{E}_{t+1}[EPS_{i,h}] - \mathbb{E}_t[EPS_{i,h}]}{\mathbb{E}_t[EPS_{i,h}]} \times 100$, when $\mathbb{E}_t[EPS_{i,h}] > 0$, as in Landier and Thesmar (2020). Summary statistics of the forecast revisions are reported in Table A2.

Table 5 shows the results of regressions of forecast revisions between March and April 2019 on carbon intensity measures. The specifications include as controls the same firm variables introduced in Section 4, along with the *Earning surprise*, the percentage deviation of the actual reported EPS from the consensus forecast. This variable captures eventual surprises due to annual results disclosed by firms between January 1 and April 18, 2019.[25]

Interestingly, carbon intensive firms appear to have experienced a decrease in analysts' forecast about their operating performance at the 2021 horizon. This finding holds both when using the carbon intensity measure at the country-industry and firm levels. Specifically, a one-standard-deviation higher *Carbon intensity (firm)* is associated with an approximately 1.50% (0.94 × 1.60) relative reduction in analysts' three-year-ahead consensus forecast. At shorter horizons, we do not observe any statistically significant change

[25] As a sanity check, Figure A1 shows in a binned scatter plot that revisions in median forecasts between March and April 2019, are positively correlated with raw returns over the same period, as one would expect. Investors and analysts both react to new material information, and also influence each others. The positive relation between stock returns and analyst's forecast revisions is a well-established finding. See Kothari et al. (2016) for a review of the literature on analysts' forecasts and asset pricing.

Table 5
Revisions of analyst's earnings forecasts and carbon intensity. The table reports estimation results of revisions in analysts' earning forecasts between March 14 and April 18, 2019, on carbon intensity measures at the country-industry level (columns 1–3) and firm level (columns 4–6). Revision in earnings forecast is defined as the percentage change in median EPS forecasts on individual firms at a given horizon. All specifications control for firm characteristics, including the earning surprise. *t*-statistics based on robust standard errors are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	ΔEPS-2019	ΔEPS-2020	ΔEPS-2021	ΔEPS-2019	ΔEPS-2020	ΔEPS-2021
Carbon intensity (country-industry)	−0.176	0.082	−0.919***			
	(−0.545)	(0.374)	(−2.791)			
Carbon intensity (firm)				−0.306	−0.189	−1.604**
				(−0.803)	(−0.415)	(−2.358)
Observations	2143	2408	1780	1432	1595	1383
R-squared	0.017	0.017	0.020	0.048	0.070	0.056
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	No	No	No	Yes	Yes	Yes
Country FE	No	No	No	Yes	Yes	Yes

Table 6
Post-event analysis of stock returns. The table reports estimation results of regressions of CAPM-adjusted cumulative returns from March 14 through June 30, 2019 (75 trading days), on carbon intensity measures at the country-industry level (columns 1 and 3), and firm level (columns 2 and 4). *News* is the logarithm of the total number of news covering a company in 2019. All specifications include firm characteristics. Specifications 3 and 4 include sector and country fixed effects. *t*-statistics based on robust standard errors are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	CAPM-adjusted CAR March 14–June 30, 2019			
Carbon intensity (country-industry)	−0.875**		2.643	
	(−1.963)		(1.176)	
Carbon intensity (firm)		−2.307***		3.397
		(−3.326)		(1.089)
News			−0.114	−0.636
			(−0.147)	(−0.674)
Carbon intensity (country-industry)×News			−0.455*	
			(−1.670)	
Carbon intensity (firm)×News				−0.731**
				(−1.983)
Observations	4172	1852	3721	1686
R-squared	0.007	0.104	0.036	0.104
Controls	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes
Country FE	No	Yes	No	Yes

in median earnings forecasts associated with firms' carbon intensity.[26] We interpret this finding as suggesting that the impact of climate activism and its consequences on firms' cash flows are more likely to materialize in the longer rather than in the short term, most likely because of the inherently long-term nature of both climate change and environmental regulations impact.

6. Post-event analysis and attention to climate activism

Consistent with the event study literature, we have so far analyzed the cross-section of stock price reactions to the first Global Climate Strike using a relative short event window of 5 trading days [−1,+3]. In this section, we extend the analysis through the end of the second quarter of 2019 to investigate whether, in a longer time frame, the observed effect for firms with high carbon intensity has been temporary or a reversal of the return pattern has followed. In addition, such longer time frame allows us to better study the role of media and public attention to climate activism. Previous studies find that higher public attention to climate change is negatively associated to stock returns of carbon-intensive firms and increases the cost of option protection against carbon tail risk (Choi et al., 2020, and Ilhan et al., 2021).

Table 6 reports the results of cross-sectional regressions using as dependent variable the cumulative abnormal returns from the day

[26] An alternative definition, adopted for instance in Ivković and Jegadeesh (2004), is to use the absolute value of the baseline forecast ($\left| \mathbb{E}_t \left[eps_{i,h} \right] \right|$) at the denominator. The choice between the two alternative definitions has no impact on our findings. Furthermore, the results are qualitatively unchanged also when accounting for firms' Market beta, to control for the effect of eventual changes in macroeconomic conditions, and for the number of analysts covering the company.

Table 7
Effect of public attention to climate activism and news on daily returns. The table reports estimation results of Eq. (3) of daily CAPM-adjusted returns from March 1, 2019 through June 30, 2019. *SVI Greta Thunberg* is the Google search value index for the term "Greta Thunberg". *SVI Greta Thunberg (firm)* is a rescaled index of the *SVI Greta Thunberg* multiplied with daily number of news for each firm. All regressions include firm characteristics and day fixed effects. Specifications 2 and 4 include also sector and country fixed effects. *t*-statistics based on standard errors clustered at daily level are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	Daily CAPM-adjusted return			
Carbon intensity (country-industry)	0.004		−0.007	
	(0.374)		(−0.855)	
Carbon intensity (country-industry)× SVI Greta Thunberg	−0.001***			
	(−2.973)			
Carbon intensity (firm)		0.015		−0.010
		(0.660)		(−0.635)
Carbon intensity (firm)× SVI Greta Thunberg		−0.003***		
		(−3.361)		
SVI Greta Thunberg (firm)			0.030	0.035*
			(1.568)	(1.730)
Carbon intensity (country-industry)×SVI Greta Thunberg (firm)			−0.019**	
			(−2.072)	
Carbon intensity (firm)×SVI Greta Thunberg (firm)				−0.089**
				(−2.240)
Observations	312293	135068	271607	122585
R-squared	0.003	0.015	0.006	0.015
Firm controls	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes
Country FE	No	Yes	No	Yes
Day FE	Yes	Yes	Yes	Yes

before our event of interest (March 14, 2019) through June 30, 2019, for a total of 75 trading days. When considering such long horizon, the coefficients of carbon intensity measures are still negative and statistically significant (specifications 1 and 2), suggesting a persistence over time of the investors' reaction to the first Global Climate Strike.

In specifications 3 and 4, we add as control variable *News*, defined as the logarithm of total number of daily news in the period under investigation of each firm, and its interaction with carbon intensity measures.[27] The negative sign of the interaction term suggests that a higher number of news concerning carbon-intensive firms is associated with lower cumulative abnormal returns.

Next, we investigate the effect on prices of daily variations in the attention to climate activism. As main proxy, we use the Google search value index activity for "Greta Thunberg" over the period between March 1 and June 30, 2019. The Google search frequency measures the intensity of searches on a term or a topic during a given period of time in a specific area. In the literature, it has been considered a good proxy for the interest and attention to a particular issue and has been applied to a range of topics (Da et al., 2011, and Choi and Varian, 2012), including climate change and global warming (Choi et al., 2020, and Ilhan et al., 2021). We look at the attention to Greta Thunberg because her name has the advantage of being internationally recognized and unequivocally associated to young climate activism. After the first Global Climate Strike, Greta Thunberg undertook an intense travelling across Europe for a series of official and awareness-raising initiatives, receiving extensive media coverage.

To investigate the relationship between stock returns and public attention to climate activism, we estimate the following model for daily abnormal returns $AR_{i,\ t}$ from March 1 through June 30, 2019:

$$AR_{i,t} = \alpha + \beta_1 CI_i \times SVIGretaThunberg_t + \beta_2 CI_i + \beta_3 SVIGretaThunberg_t + X_i^{'}\gamma + \tau_t + \varepsilon_{i,t}, \quad (4)$$

where $SVIGretaThunberg_t$ is the Google search value index (SVI) for the topics "Greta Thunberg" defined for each date t. β_1 is the parameter measuring the interaction between carbon intensity level and the attention for Greta Thunberg. X_i is the vector of accounting variables, and τ_t is the time fixed effect.

The results are reported in Table 7. The estimated coefficient on the interaction term between carbon intensity (both at the firm- and country-industry level) and the daily attention to climate activism is negative and statistically significant. Then, we define the *SVI Greta Thunberg (firm)*, a new variable defined as *SVI Greta Thunberg* times the number of daily media news covering each firm.[28] In specifications 3 and 4, the coefficients of the interaction terms with respect to carbon intensity are negative and statistically significant.[29]

[27] Data on news are downloaded from Bloomberg, which provides a counting of the daily number of news concerning a firm, independently on the topic of the news.
[28] Since *SVI Greta Thunberg* ranges from 0 to 100, the variable at firm level is normalized to 100 (with a standard deviation of 0.8330).
[29] As an alternative proxy for attention to climate activism, we also retrieve the Google search value index for the term "Fridays for future" (both indexes are plotted in Appendix Figure A2). The results are in line with those reported in Table 7.

Overall, these analyses indicate that a higher public attention to climate activism is associated with a higher stock-price penalty on firms producing more negative climate externalities, particularly for those with a more intense media exposure. Despite the fact that this investigation concerns a longer time frame, our findings suggest that the public and media attention to climate activism has contributed to the negative stock price reaction on carbon-intensive firms documented in Section 4.

7. Conclusion

In recent years, the increasing concerns for the future effects of global warming have given rise to an unprecedented wave of environmental activism, especially by young people. In this paper, we study whether and how this call for bolder climate actions is influencing financial markets.

By analyzing the stock prices of a large sample of European firms around the occurrence of the first Global Climate Strike in March 2019, we provide evidence of a significant loss in market valuation for carbon-intensive firms. This stock-price penalty persists over time. We explore a set of possible determinants. The effect is larger for firms located in countries performing worse in terms of environmental indicators, presumably because of their higher exposure to steeper future tightening in regulation. We find no evidence that the results are significantly driven by institutional investors. However, we show that financial analysts revised downward their longer-run earnings expectations on carbon-intensive firms. Furthermore, we show that the negative pricing of carbon intensity is influenced by higher public attention to climate activism.

Taken together, our results warn investors and firms of the fact that the timing in the “stranding” of carbon-intensive assets is marked not only by the passing of new regulations, but also by perhaps more unpredictable factors, such as public attention and activism on climate-related issues.

Declaration of Competing Interest

The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

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Appendix A. Supplementary data

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